Supporting information

Ni doped Mo$_2$C/NCF composite for efficient electrocatalytic hydrogen evolution

Jie Yang$^1$, Tariq Bashir$^1$, Yanping Lin$^2$, Lijun Gao$^1$

1. College of Energy, Soochow Institute for Energy and Materials Innovations, Soochow University, Suzhou 215006, China

2. School of Physics and Energy, Xuzhou University of Technology, Xuzhou 221018, China

* Corresponding author: gaolijun@suda.edu.cn (L. Gao)

**Fig. S1** Thermo-gravimetric profile of dopamine-chelating ammonium molybdate.
**Fig. S2** SEM images of the molybdenum carbide material at (a) 700°C and (b) 800°C
Fig. S3. Structural characterizations of molybdenum carbide, (a) SEM image of NCF, (b) TEM image, and (c) EDS elemental mapping of Mo$_2$C/NCF. (d) TEM image of Ni-Mo$_2$C/NCF.
Fig. S4. (a) Nitrogen adsorption-desorption isotherm of Ni-Mo$_2$C/NCF at 77 K, (b) XPS survey spectrum of Mo$_2$C/NCF showing the presence of Mo, N, C and Ni elements.
**Fig. S5.** CV curves of (a) Ni-Mo$_2$C/NCF and (b) Mo$_2$C/NCF under different scan rates from 20 to 160 mV/s in 1.0 M KOH.

**Fig. S6.** XRD of Mo-chelated polydopamine.
Fig. S7. Nyquist plots of Ni-Mo$_2$C/NCF and Mo$_2$C/NCF in 1.0M KOH at open circuit potential.
**Conversion method of $E_{RHE}$**

Based on the Nernst equation we can derive:

$$E_{RHE} = E_{test} + 0.059 \times pH + E_R,$$

where $E_{test}$ is the original voltage applied during the test, $E_R$ is the standard electrode potential of the reference electrode, the value of pH is about 13.6 in 1M KOH solution. In this work, the reference electrode was Hg/HgO, $E_R=0.098$V

$$E_{RHE} = E_{test} + 0.059 \times 13.6 + 0.098$$

$$= E_{test} + 0.9004$$

**Calculation of ECSA**

Based on the linear fitting of Fig. 3d insert, we can derive specific capacitance of Ni-Mo$_2$C/NCF as follows:

$$C = \frac{k}{2m} = \frac{21.6 mF/cm^2}{2 \times 0.28 mg/cm^2} = 38.6 F/g,$$

where $C$ is the specific capacitance of Ni-Mo$_2$C/NCF, $k$ is the fitting slope, $m$ is the catalyst areal loading.

Then, we can calculate its ECSA of Ni-Mo$_2$C/NCF by assuming a standard value of 30 $\mu$ F/cm$^2$ (it is commonly used for many oxide surfaces):

$$ECSA = \frac{C}{30 \ \mu \ F/cm} = 128.6 \ m^2/g$$